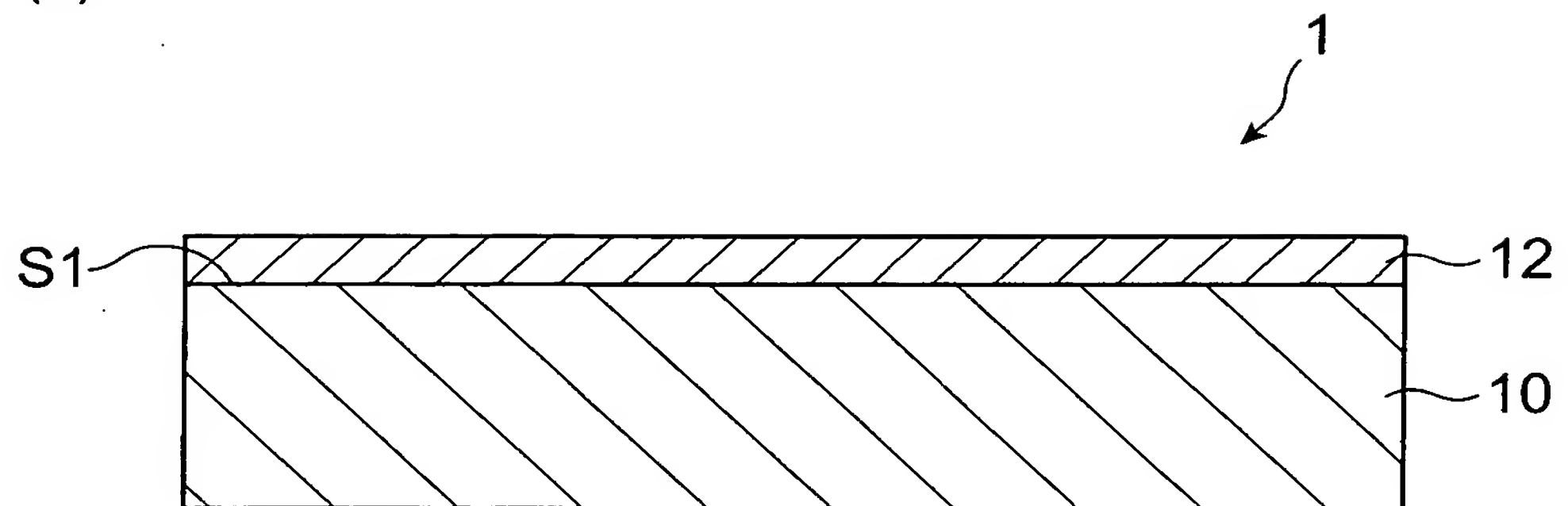


Fig.1

(a)



(b)

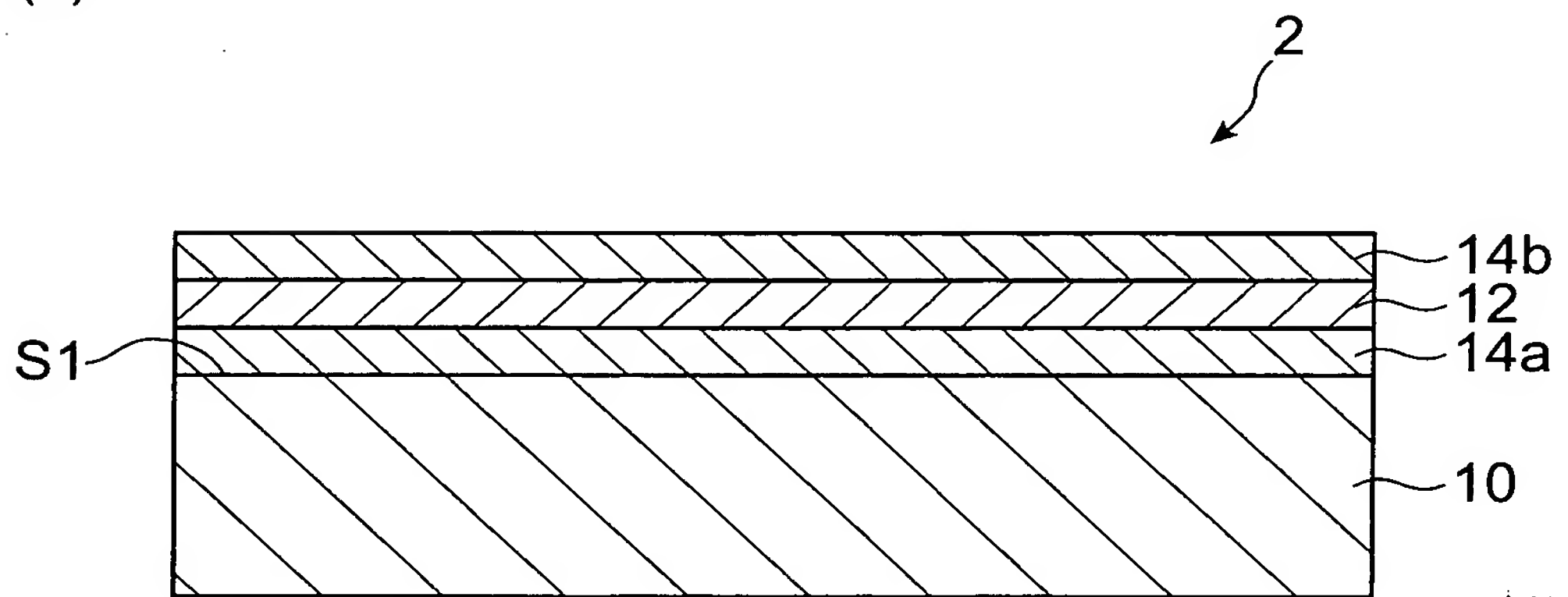
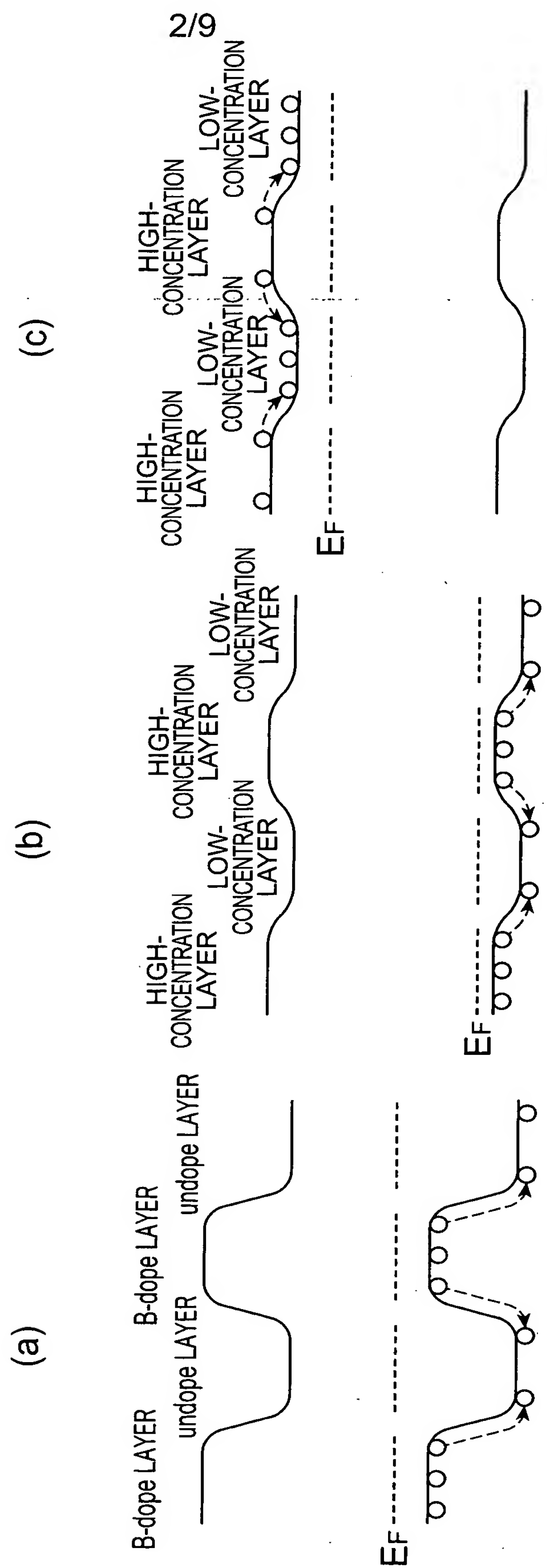
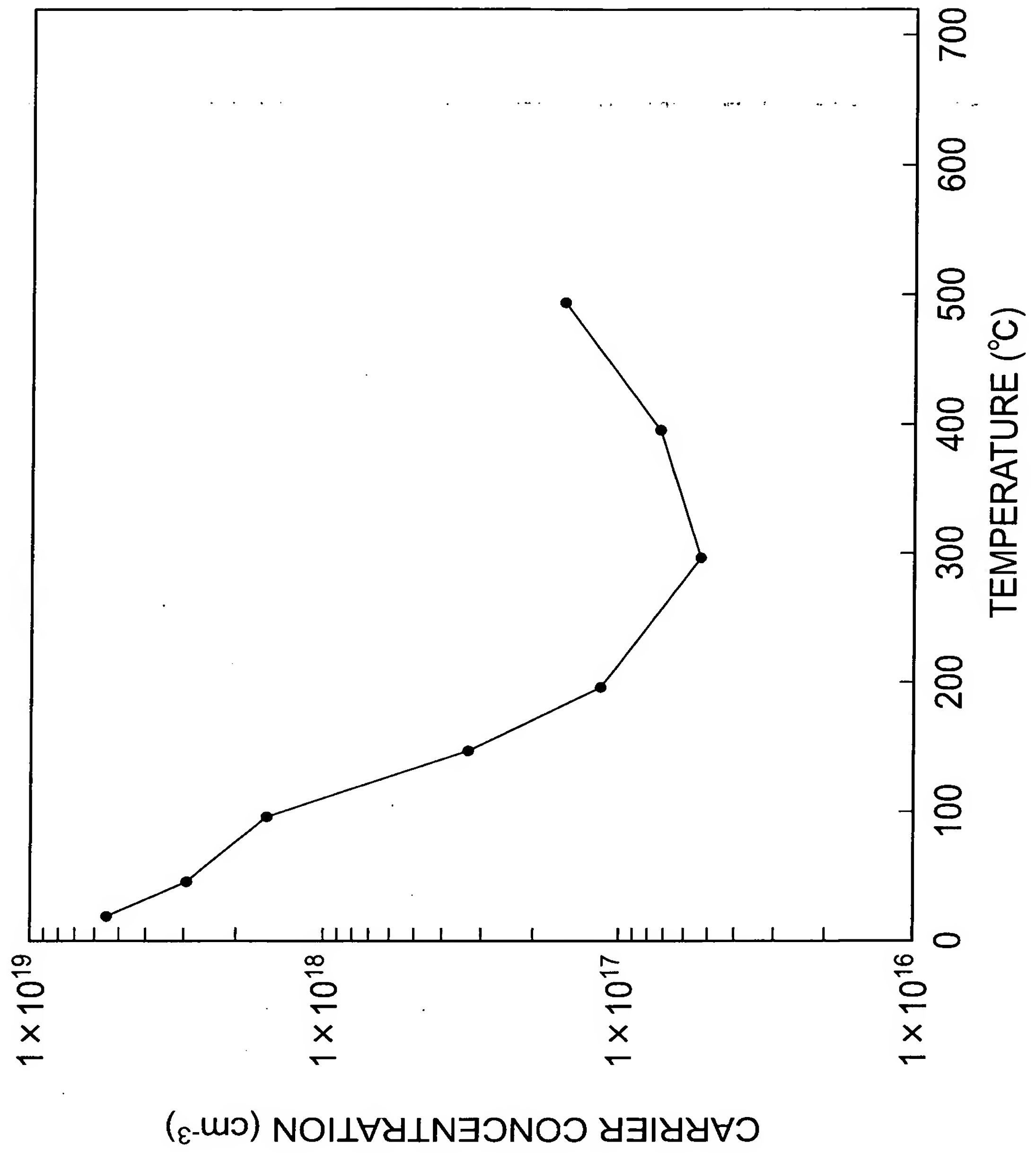
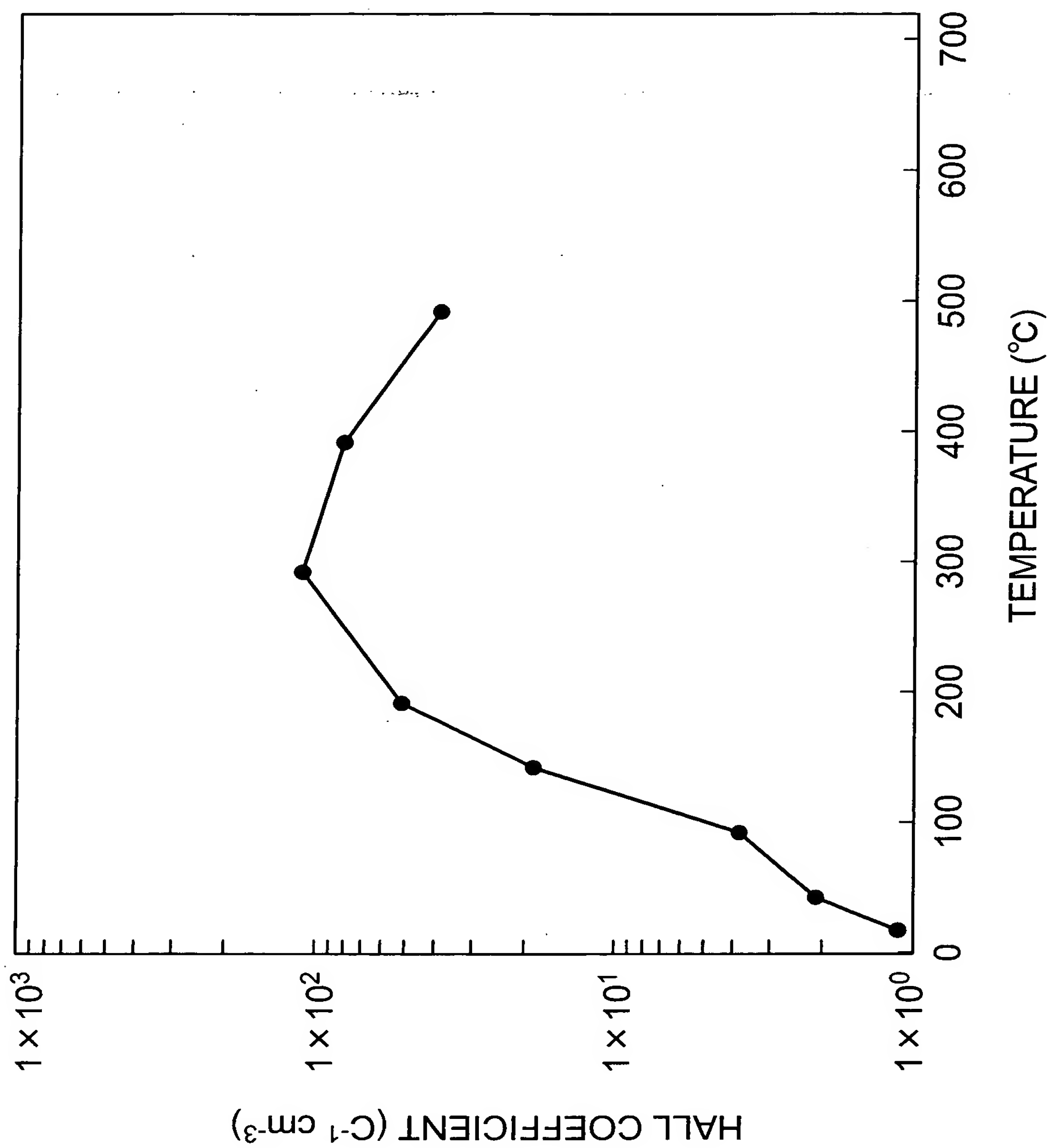


Fig.2



**Fig.3**

**Fig.4**

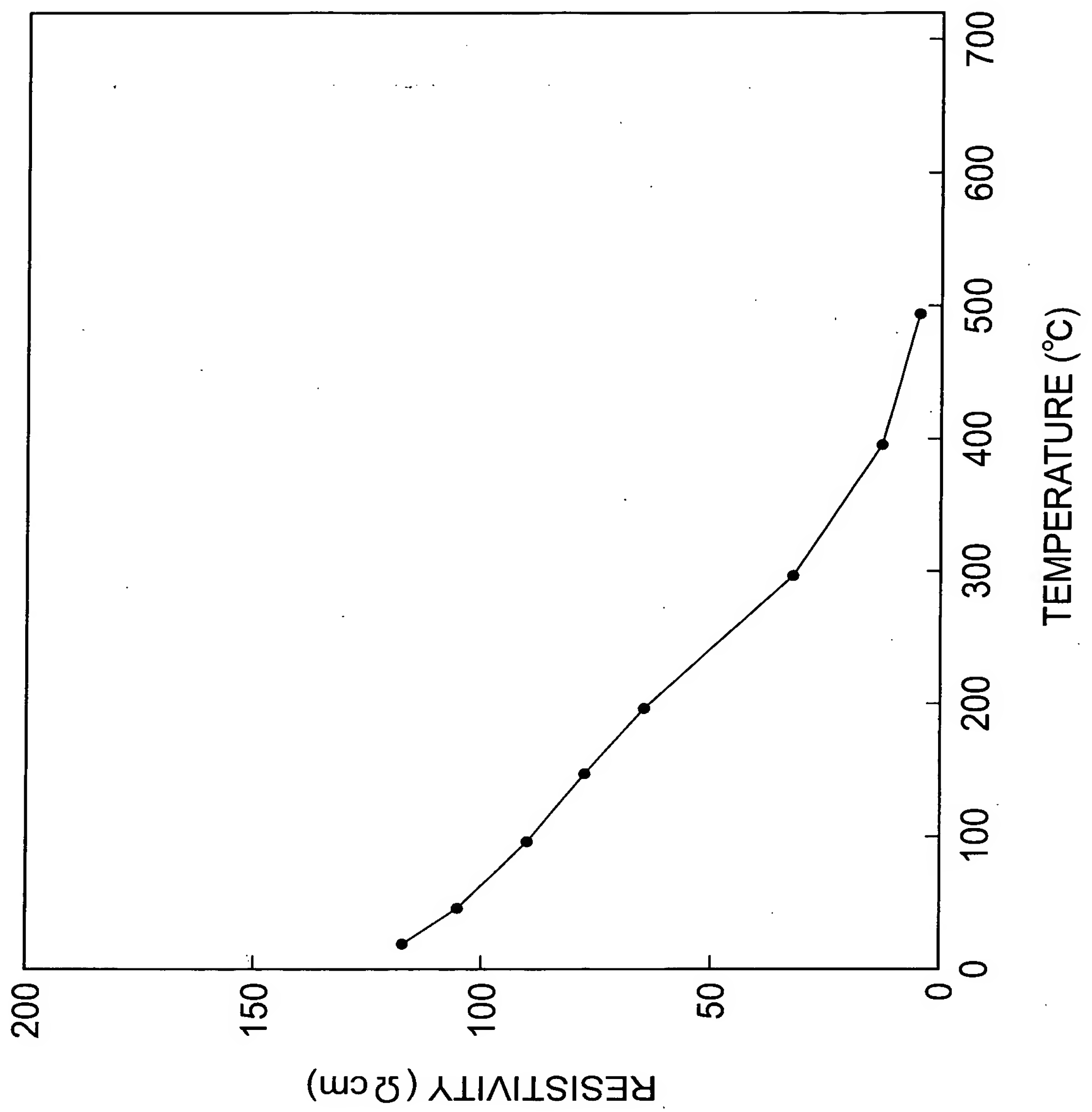
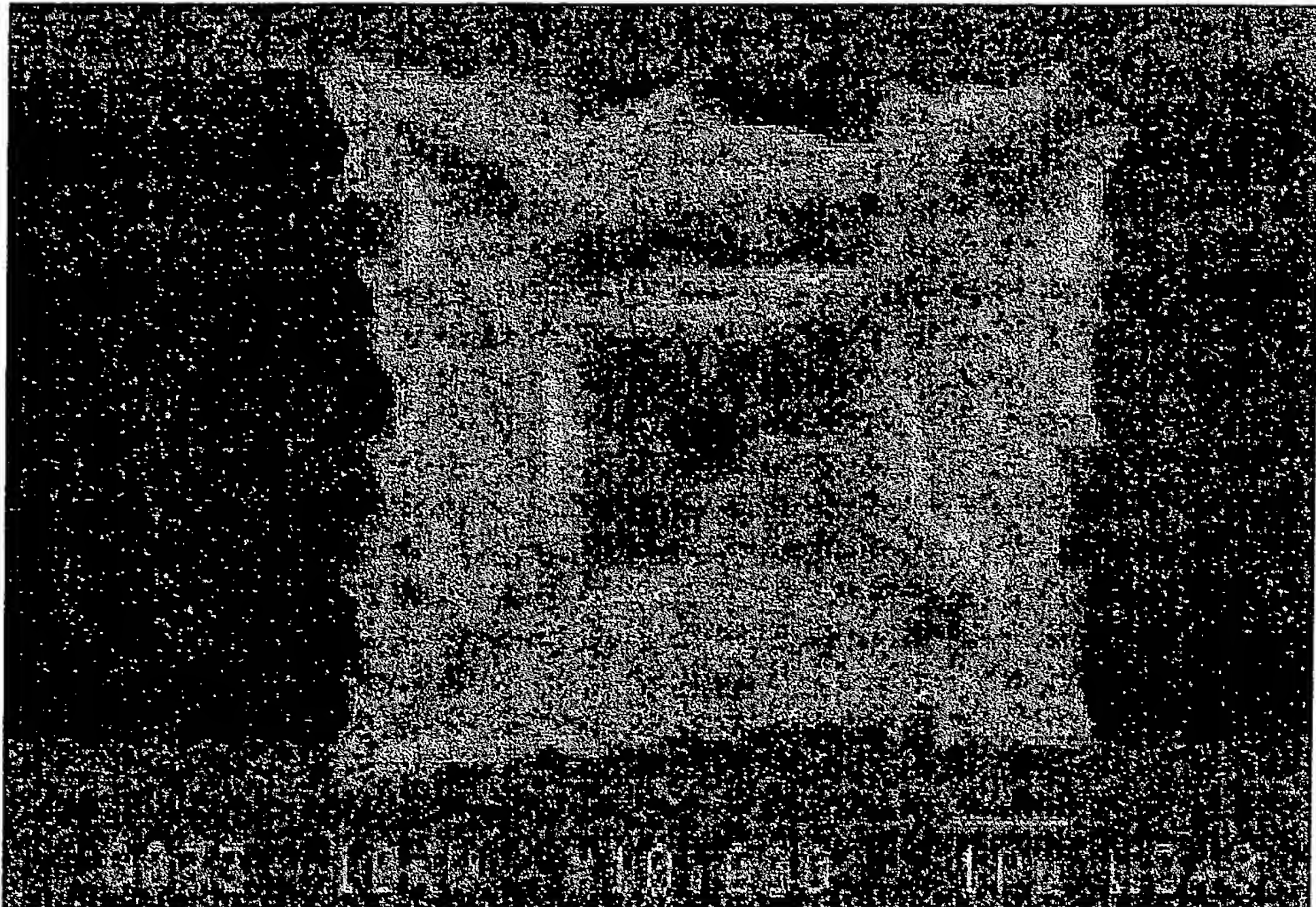
**Fig.5**

Fig.6



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Fig.7

METHANE CONCENTRATION (CH ₄ /H ₂) [%]	PHOSPHINE CONCENTRATION (PH ₃ /CH ₄) [ppm]	N-TYPE DETERMINATION	CORRELATION OF CARRIER CONCENTRATION WITH TEMPERATURE	CORRELATION HALL COEFFICIENT WITH TEMPERATURE	MINIMUM CARRIER CONCENTRATION	RESISTIVITY AT ROOM TEMPERATURE	THRESHOLD VOLTAGE
0.05	200000	N-TYPE	+(700°C~350°C) -(350°C~100°C)	-(700°C~350°C) +(350°C~100°C)	~ 5 × 10 ¹⁵	100	400
0.03	200000	N-TYPE	+(700°C~350°C) -(350°C~70°C)	-(700°C~350°C) +(350°C~70°C)	~ 8 × 10 ¹⁶	80	350
0.005	200000	N-TYPE	+(700°C~350°C) -(350°C~50°C)	-(700°C~350°C) +(350°C~50°C)	~ 2 × 10 ¹⁷	50	300
1.0	22000	NOT DETERMINABLE	NOT OBSERVABLE	NOT OBSERVABLE			
0.5	22000	N-TYPE	+(700°C~300°C) ALONE	-(700°C~300°C) ALONE	~ 4 × 10 ¹⁵	800	1100
0.1	22000	N-TYPE	+(700°C~300°C) -(300°C~180°C)	-(700°C~300°C) +(300°C~180°C)	~ 1 × 10 ¹⁶	300	550
0.05	22000	N-TYPE	+(700°C~300°C) -(300°C~100°C)	-(700°C~300°C) +(300°C~100°C)	~ 3 × 10 ¹⁶	250	500
0.03	22000	N-TYPE	+(700°C~300°C) -(300°C~50°C)	-(700°C~300°C) +(300°C~50°C)	~ 5 × 10 ¹⁶	200	400
0.005	22000	N-TYPE	+(700°C~300°C) -(300°C~30°C)	-(700°C~300°C) +(300°C~30°C)	~ 6 × 10 ¹⁶	180	400
0.003	22000	NOT DETERMINABLE	NOT OBSERVABLE	NOT OBSERVABLE			
0.1	18000	N-TYPE	+(700°C~150°C) -(150°C~60°C)	-(700°C~150°C) +(150°C~60°C)	~ 2 × 10 ¹⁵	700	1000
0.05	18000	N-TYPE	+(700°C~100°C) -(100°C~20°C)	-(700°C~100°C) +(100°C~20°C)	~ 1 × 10 ¹⁵	900	1000
0.1	11000	N-TYPE	+(700°C~200°C) ALONE	-(700°C~200°C) ALONE	~ 6 × 10 ¹⁴	1000	1500
0.05	11000	N-TYPE	+(700°C~150°C) ALONE	-(700°C~150°C) ALONE	~ 8 × 10 ¹⁴	800	1100
0.05	1000	NOT DETERMINABLE	NOT OBSERVABLE	NOT OBSERVABLE			
0.05	1000	N-TYPE	+(700°C~30°C) ALONE	-(700°C~30°C) ALONE	~ 3 × 10 ¹³	20000	2000
0.03	1000	N-TYPE	+(700°C~30°C) ALONE	-(700°C~30°C) ALONE	~ 4 × 10 ¹³	20000	1800
0.005	1000	N-TYPE	+(700°C~30°C) ALONE	-(700°C~30°C) ALONE	~ 6 × 10 ¹³	15000	1500

Fig.8

METHANE CONCENTRATION (CH ₄ /H ₂) [%]	PHOSPHINE CONCENTRATION (PH ₃ /CH ₄) [ppm]	Si CONCENTRATION [cm ⁻³]	N-TYPE DETERMINATION	CORRELATION OF CARRIER CONCENTRATION WITH TEMPERATURE	CORRELATION HALL COEFFICIENT WITH TEMPERATURE	MINIMUM CARRIER CONCENTRATION	RESISTIVITY AT ROOM TEMPERATURE	THRESHOLD VOLTAGE
0.05	22000	1 × 10 ¹⁹	N-TYPE	+(700°C~300°C) -(300°C~100°C)	-(700°C~300°C) +(300°C~100°C)	~ 4 × 10 ¹⁶	200	400
0.03	22000	8 × 10 ¹⁸	N-TYPE	+(700°C~300°C) -(300°C~70°C)	-(700°C~300°C) +(300°C~70°C)	~ 6 × 10 ¹⁶	150	350
1	1000	3 × 10 ¹⁹	NOT DETERMINABLE	NOT OBSERVABLE	NOT OBSERVABLE			
0.5	1000	1 × 10 ¹⁹	N-TYPE	+(700°C~500°C) ALONE	-(700°C~500°C) ALONE	~ 8 × 10 ¹⁴	1000	1100
0.1	1000	8 × 10 ¹⁸	N-TYPE	+(700°C~300°C) -(300°C~150°C)	-(700°C~300°C) +(300°C~150°C)	~ 4 × 10 ¹⁶	400	600
0.05	1000	3 × 10 ¹⁸	N-TYPE	+(700°C~280°C) -(280°C~80°C)	-(700°C~280°C) +(280°C~80°C)	~ 5 × 10 ¹⁶	200	450
0.5	5000	2 × 10 ¹⁸	N-TYPE	+(700°C~400°C) ALONE	-(700°C~400°C) ALONE	~ 5 × 10 ¹⁴	1500	1500
0.1	5000	8 × 10 ¹⁷	N-TYPE	+(700°C~300°C) -(300°C~150°C)	-(700°C~300°C) +(300°C~150°C)	~ 1 × 10 ¹⁶	500	700
0.05	5000	2 × 10 ¹⁷	N-TYPE	+(700°C~250°C) -(250°C~50°C)	-(700°C~250°C) +(250°C~50°C)	~ 2 × 10 ¹⁶	300	500
0.5	1000	9 × 10 ¹⁸	N-TYPE	+(700°C~200°C) ALONE	-(700°C~200°C) ALONE	~ 1 × 10 ¹⁴	7000	2000
0.03	1000	10 × 10 ¹⁶	N-TYPE	+(700°C~200°C) ALONE	-(700°C~200°C) ALONE	~ 2 × 10 ¹⁴	4000	1800

Fig.9

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METHANE CONCENTRATION (CH ₄ /H ₂) [%]	PHOSPHINE CONCENTRATION (PH ₃ /CH ₄) [ppm]	Si CONCENTRATION [cm ⁻³]	N-TYPE DETERMINATION	CORRELATION OF CARRIER CONCENTRATION WITH TEMPERATURE	CORRELATION HALL COEFFICIENT WITH TEMPERATURE	MINIMUM CARRIER CONCENTRATION	RESISTIVITY AT ROOM TEMPERATURE	THRESHOLD VOLTAGE
0.05	22000	2 × 10 ¹⁹	N-TYPE	+(700°C~350°C) -(350°C~80°C)	-(700°C~350°C) +(350°C~80°C)	~ 6 × 10 ¹⁶	100	350
0.05	5000	8 × 10 ¹⁸	N-TYPE	+(700°C~280°C) -(280°C~50°C)	-(700°C~280°C) +(280°C~50°C)	~ 2 × 10 ¹⁶	350	500
0.05	22000	9 × 10 ¹⁸	N-TYPE	+(700°C~300°C) -(300°C~100°C)	-(700°C~300°C) +(300°C~100°C)	~ 6 × 10 ¹⁶	150	400
0.05	10000	1 × 10 ¹⁸	N-TYPE	+(700°C~280°C) -(280°C~80°C)	-(700°C~280°C) +(280°C~80°C)	~ 5 × 10 ¹⁶	250	450
0.05	5000	4 × 10 ¹⁸	N-TYPE	+(700°C~280°C) -(280°C~90°C)	-(700°C~280°C) +(280°C~90°C)	~ 3 × 10 ¹⁶	500	600